ness and incompleteness with which reorganisation is going on in the studies concerned with man is an undesirable, even a dangerous, fact. The disparity between the two halves of human knowledge has grown so great that there is a fear that almost all young men of original or inventive mind will turn to the study of material nature. It would be foolish to make any comparison between the importance of the knowledge of man's surroundings and the knowledge of his nature, his works, and his history. Both are beyond value. But if the two halves of the human brain, so to speak, work on different plans, what will become of the unity of man himself?

A reason why the votaries of natural science should have some sympathy with those who are endeavouring to remodel humanist studies is that it is from the natural sciences that methods and ideas have flowed into those relating to man. The ideas of continuity, of adaptation to environment, of evolution, were transplanted into historic studies from those of biology, and it was soon found that they flourished almost as well, and bore almost as much fruit, in the new field as in the old. But whereas the highly trained and scientific worker in history, psychology, archæology, and kindred studies is quite alive to the use of the new scientific methods, they have as yet only partially affected education in these subjects, even in our universities. The books used by the students are changed in character, but not the ways of working. Undergraduates are not thoroughly taught the principles of weighing evidence, they are not accustomed to work on the comparative method, they do not acquire historic imagination. They have not learned to judge by evidence rather than by authority, nor rigidly to distinguish degrees of probability.

Of course, education is not, and cannot be, only scientific. To everyone's education there should be other sides. There should be a religious side, in some ways the most important of all. There should be an artistic side. Every boy and every girl should be taught to draw or to play some instrument, and to appreciate good work done in the art which is thus practised. And every student should be taught to use the English language to some purpose, and to appreciate what has been best written in that language, and in one or two other languages. But at present I am not speaking of religious, of artistic, or of literary education, but of scientific education, of the direct training of the faculties for dealing with the facts of the world; and it is my contention that this scientific side of education has been comparatively neglected in the case of those who have not taken up some branch of physical science. In fact, so completely has the really scientific character of such studies as history and archæology and economics and the like been, at least in this country, overlooked that when we hear of a man studying science it is at once assumed that he is giving his attention to the facts of the natural rather than of the human world. But the word science has not and cannot rightly have any meaning but "ordered knowledge." Whatever can be surely known is matter of science.

But I must come to the practical question of the organisation of study, and especially of university study. Knowledge of the physical world has so greatly grown by two things, the improvement of method and the organisation of research. Improved methods of investigation in the study of man and of history have fairly come in: they are scarcely yet fully recognised in schools and universities, but the best authorities in the various branches of the subject are acquainted with them. What is most needed is a new organisation of research.

At present in our universities the spread of better methods in the human studies has principally effected this, that the student works on better text-books. This in itself is something, but not very much. Compare, for example, such a subject as geology. Would it be regarded as sufficient if the students of geology read books in which the latest and most approved views are expressed? Surely not; until the student has grubbed for himself in the chalk pit and the cliff, and learned in museums to recognise the substances belonging to various strata of the earth, he has done nothing worth doing. He must not take results ready made, but must work for himself see for himself, learn the value of evidence and the touch of fact. I venture to think that the case is the same in human studies. Here also it is of little use to accept the best results, unless the student grasps the grounds on which they are reached. Here also he must for himself work on the data, see why one view is more probable than another, map out the exact state of the evidence.

Our remedy is to adopt in the human sciences organisation and methods of study which have triumphed in the natural sciences. In every college and university there should be, beside the laboratory of the chemist and the dissecting room of the physiologist, work-rooms for the students of man. As regards psychology and anthropology, which are two foundation stones of the arch, this is already conceded. Specimens and apparatus are there acknowledged to be necessary. The same necessity exists as regards other branches of human study. Work-rooms are needed in which the student should be, so far as possible, brought into contact with evidence. All the important books, dictionaries and the like should, of course, be there. And besides, the authorities for the books should be so far as possible put together, facsimiles of documents and of inscriptions, maps, chronicles, coins, seals, and the like. In the economic section every kind of statistics should be at hand. In the department of ancient history there should be casts of inscriptions, photographs of sites, facsimiles of manuscripts, casts of statues and of coins. Even when such objects are not direct authorities for the points of which the student is in search, they form his mind by bringing him into contact with fact and evidence, and they greatly stimulate his imagination by placing him in presence of some of the surroundings of history. The result of work of this kind would be a change of outlook and of method, the substitution of investigation for theory, of science for fancy. It would prepare the student for wider work in the actual world, for which, of course, it would be no substitute but a *propaedeutic*.

Those who teach and organise natural studies are fully alive to the great demands made by the changed state of the world, and are demanding endowment with energy and persistency. They are quite right. But the teachers of human studies are more inert and less keenly alive to the need of expansion. But science, ordered knowledge, is, in spite of all divisions, one, and it will be a great misfortune for the country if in the extension and re-endowment of our university system the necessity of thorough and elaborate investigation of man in all his aspects, his history and his works, falls into the background.

Oxford, October. P. GARDNER.

Uniformity in Scientific Literature.

IN 1894 a committee was appointed by the British Association to inquire into the question of uniformity in the size of the pages of proceedings, transactions, and scientific journals in which original papers are published. The appearance of a number of *Proceedings* of the London Mathematical Society of a different size from its predecessors, in accordance with an announcement circulated as recently as the end of August, suggests that it may be desirable to direct attention to the report of this committee (Brit. Ass. Rep., 1895, p. 77).

In this country all the more important octavo journals in question are printed on either medium or demy paper; as examples we may cite the Royal Society's *Proceedings*, the *Philosophical Magazine*, the *Proceedings* of the Physical Society, &c. A considerable number of foreign journals (*e.g.* Wiedemann's *Annalen*) are of practically the same size. The difference between medium and demy octavo is too small to cause any inconvenience either in placing the volumes together on a shelf or in binding together reprints of papers. In the case of certain American and Italian journals a somewhat larger sized page has been adopted, but the difference is entirely in the margin, the printed portion being in some cases smaller even than in our demy octavo journals. This allows of reprints being cut down for binding with others from the *Philosophical Magazine* or British Association *Report*, and still leaving plenty of margin. Where papers are too long to be published in octavo form, medium and demy quarto are the most prevalent sizes. Here again there is not much to choose between the two, and, as in the case of octavo, the committee decided to recommend the demy size as a standard. The most inconvenient pamphlets to deal with are those in which the paper is too small for binding up

with demy quarto, and the printed page is too large to allow of the paper being cut down to demy or even medium octavo size. The *Atti* of the Lincei Academy may be cited as an important example. Fortunately, however, such exceptions are comparatively few in number, and they include none of the main English journals in which original papers are published on mathematics or physics.

It is my hope that by again directing attention to this matter further uniformity may be secured in the sizes of proceedings and transactions by the gradual elimination of inconvenient sizes, and by the avoidance of further divergences. The size of the new number of London Mathematical *Proceedings* is peculiarly unfortunate, as it is not uniform even with those outstanding foreign journals which do not conform to the recommendations of the committee.

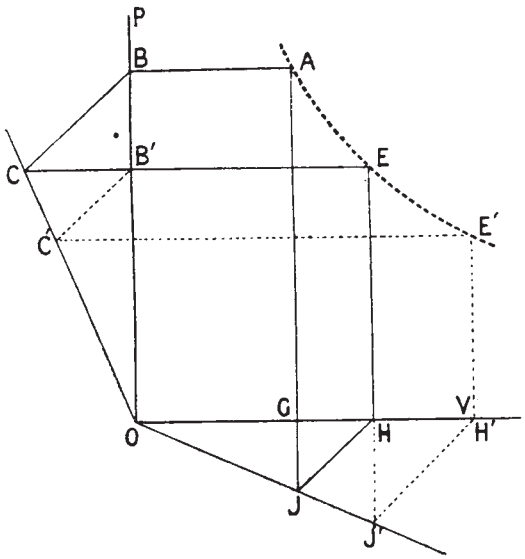
G. H. BRYAN.

Expansion Curves.

MR. STODDART'S method of finding points on the curve pv^n = constant, to which Prof. Perry directed attention on October 8 (p. 548), is interesting, but it does not give a great number of convenient points on the curve. If the points A, E, . . . are called (v_1, p_1), (v_2, p_2), . . ., the values of v and p form two series of quantities in continued proportion, *i.e.* such that $v_1/v_2 = v_2/v_3 = \ldots$, and $p_1/p_2 = p_2/p_3 = \ldots$

A modification of the method, bringing out more clearly its essential simplicity, and, moreover, far easier in practice, would be to calculate the positions of *two* points A, E instead of finding A and the specially related angles α, β.

It will then be seen from the diagram, by drawing the lines needful to find a third point (say for definiteness in



the direction of increasing v and decreasing p), that the method advocated is only that of finding the above two series of continued proportionals, and that *any* angles would serve the purpose, all that is necessary being that all the construction lines like JH must be parallel to each other, and similarly all the lines like BC parallel to each other. But no modification of the method will give more than the points I have indicated.

By drawing the tangents at the points so found, the accurate construction of the curve would evidently be facilitated. This can be neatly done by taking care in the choice of the first two points; for in these curves the gradient is $-p \div v/n$, so that the tangent at the point (v,p) cuts the axis of x at the point the abscissa of which is $v(1+1/n)$. Hence if we choose the first two points (v_1, p_1) and (v_2, p_2) so that $v_2 = v_1(1+1/n)$, the tangent at the first point will pass through the foot of the second ordinate, and similarly the tangent at the second point will pass through the foot of the third ordinate, and so on.

Or, if we take $v_2 = v_1\sqrt{(1+1/n)}$, so that $v_3 = v_1(1+1/n)$, the first tangent will pass through the foot of the third ordinate, and so on.

This happens to be approximately the case in Prof. Perry's diagram, which for convenience has been reproduced here with a set of additional construction lines.

Coopers Hill. ALFRED LODGE.

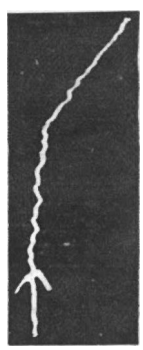
Rocket Lightning.

A PECULIAR species of lightning, bearing a strong resemblance to ascending rockets, was witnessed on the evening of July 22 by two of the professors in Sibpur Engineering College, Howrah, near Calcutta, one of whom wrote me the following careful account in a letter dated the next day. I wrote back suggesting local inquiry in the direction in which the phenomenon appeared, and sending some extracts from Hann's "Lehrbuch der Meteorologie" bearing on the subject. The reply, dated September 1, shows that the suggested inquiry is impracticable.

11 Leopold Road, Ealing, W. J. D. EVERETT.

WE saw some strange lightning yesterday evening at about 9 p.m. It was a clear, moonless night, with just a bank of cloud very low in the S.S.W., with a well-marked edge, height say from horizon (flat) to 5° up. There was a misty cloud above this. These clouds we could only see properly when the flashes came. Stars were visible at about 10° above the horizon at this point, and the sky was quite clear all over elsewhere. Now and then flashes showed from behind the lower cloud (the flashes themselves were mostly hidden, and thunder was not audible). The flashes were not so frequent as usual, say one per minute or so. Generally here they are almost incessant during thunderstorms.

At intervals of three minutes or so, immediately after a flash—which, as common here, was mostly multiple, lasting a second or so altogether—a luminous trail shot straight up to 15° or so, about as fast as, or rather faster than, a rocket, and of very similar appearance, but with minute waves, like ribbon lightning. It was hardly as bright as most lightning. S. and I saw it repeated seven times, and Prof. Brühl (physics) three or four times after we directed his attention to it. He was equally surprised at the novelty, and he has been out here some eighteen years. One of the trails turned off, as shown; the others were about vertical as seen from here. Each grew up steadily from below, and then disappeared at once. The upper end was definite, and did not branch or spread.



In each case it followed immediately on a vivid flash or set of flashes. It was certainly not fireworks of any kind. It terminated in apparently clear sky. Its appearance as a uniformly and very bright ribbon was different from any fireworks. It was somewhat yellowish, not purple as lightning often is. It was much too far off for fireworks to be so high and bright. No thunder was audible.

July 23. W. H. EVERETT.

THANKS for trouble of making extracts from Hann *re* lightning, which, as you say, describe phenomena different from what we saw.

Peake is in charge of the Meteorological Office for India, and did not hear about it, nor did I see anything in the Calcutta newspapers.

There would be practically no Europeans or any competent observers nearer the lightning than we were; as it must have occurred at a spot above the Sunderabunds, a wilderness of waterways and jungle. And there are probably not a score of men in all Bengal who would take serious interest in such lightning if they did happen to see it. I was lucky to have Brühl as a witness, he being an old resident, and one who keeps his eyes open.

It was not like a string of fireballs, for it was of uniform width. But it had, as Hann says of globular lightning, doubtless some connection with the breaking down of the air by the volleys of discharges. W. H. E.

September 1.